The corresponding Laplace domain expression for $Q_{\text{in}}(t)$ is:

$$\hat{Q}_{\text{in}}(s) = \frac{k_{\text{p}} A C_{\text{v}}}{s^2} \sqrt{st_d} \operatorname{cotanh} \sqrt{st_d} \tag{2.18}$$

The absorption rate or flux of solutes in the period before steady state is important for many agents applied topically for local effects and in the toxicology of agents applied to the skin. The flux of solutes exiting the membrane per unit area, $J_s(t)$, is defined by $J_s(t) = (1/A)\,\partial Q/\partial t$ or $\hat{J}_s(s) = s\hat{Q}(s)/A$ in the Laplace domain. Using Equations (2.9) and (2.13) we find therefore:

$$J_{\text{s}}(t) = -D_{\text{m}} \frac{\partial C_{\text{m}}}{\partial x}\bigg|_{x=h_{\text{m}}} = k_{\text{p}} C_{\text{v}} \left[1 + 2\sum_{n=1}^{\infty} (-1)^n \exp\left(-\frac{t}{t_d} \pi^2 n^2 \right) \right] \tag{2.19}$$

$$\hat{J}_{\text{s}}(s) = \frac{k_{\text{p}} C_{\text{v}}}{s} \frac{\sqrt{st_{\text{d}}}}{\sinh\left(\sqrt{st_{\text{d}}}\right)} \tag{2.20}$$

The corresponding equation for the flux of solute from the vehicle into the membrane, $J_{in}(t)$, is:

$$J_{\text{in}}(t) = k_{\text{p}} C_{\text{v}} \left[1 + 2\sum_{\text{n}=1}^{\infty} \exp\left(-\frac{t}{t_{\text{d}}} \pi^2 n^2 \right) \right] \tag{2.21}$$

$$\hat{J}_{\text{in}}(s) = \frac{k_{\text{p}} C_{\text{v}}}{s} \sqrt{st_d} \operatorname{cotanh} \sqrt{st_d} \tag{2.22}$$

Figure 2.5 shows the flux profiles for solutes leaving the membrane and vehicle, respectively.

2.1.2 Amount and Flux–Time Profiles on Removing the Donor Phase After Reaching the Steady State for Conditions Described in Section 2.1.2.A

We now consider the amount and flu–time profiles for the specific case in which the donor phase has been removed after a steady state has been reached. This equates to a number of practical cases of

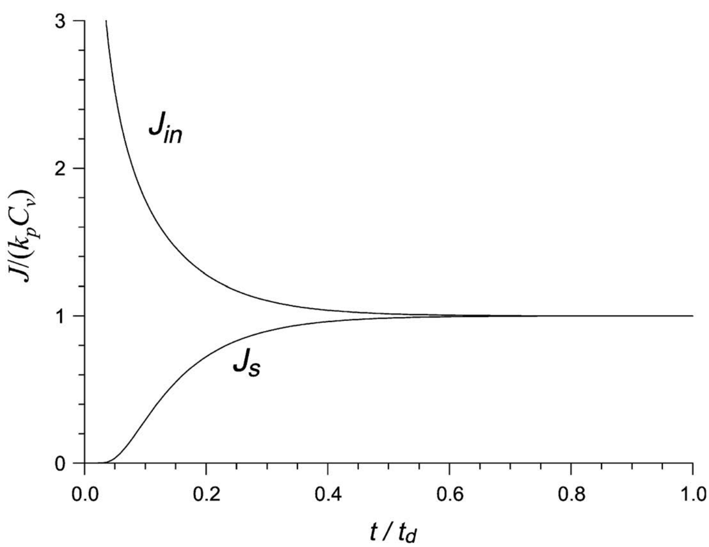

FIGURE 2.5 Normalized flux ($J/k_p C_v$) against normalized time (t/t_d) for flux of solutes penetrating the SC [J_s, Equation (2.20)] and entering the SC [J_{in}, Equation (2.22)].